DOOSAN Document Transmittal

Upper Trishuli-1 HEP (216MW)

Date	DT No.:	SHEET
2022-05-01	UT1-HEP-DHI-PC-D-0027	1 OF 1

DOOSAN NEPAL BRANCH OFFICE	Address & Contact No. : Four Square Building, Naxal, Kathmandu, Nepal (P.O Box : 1387) + 977 1 692 3014	Project No. H20002	DOCUMENT DISPATCHED BY Courier Service ☐ Messenger ☐ Post-Air Freight ☐ Document System or E-mail ■ By hand ■
DOCUMENT DISTRIBUTION	■ POWER CHINA (Subcontractor) ☐ Doosan's Site Office		
SUBJECT	Submission of Review Note RN-0116 and RN-0117		

S. N.	REVIEW NOTE NO.	REVIEW STATUS	DWG. / DOC. NO.	REV.	DWG. TITLE / DOC. DESCRIPTION	REMARK
1	RN-0116	AN	UT1-C-030-CVL-DG-51001	0B	Layout drawing of access tunnel for DS gate operating house of desander	
2	RN-0117	RR	UT1-C-030-CVL-TE-40011	0B	Physical Model Test Study Report of Desander Basin	
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Received by :

Date :

Legend of Review Status
A : APPROVED
AN : APPROVED AS NOTED
RR : RETURN FOR RESUBMISSION
FI : FOR INFORMATION

DHI STAMP

Doosan Heavy Industries & Construction Co., Ltd. DOOSAN Branch Office Nepal

Issued by DHI

Youngsoo Son

Project Manager

Email: youngsoo.son@doosan.com
Doosan Heavy Industries & Construction Co., Ltd.

Discipline : Civil

UPPER TRISHULI-1 HEP (216MW)			
Client	**Nepal Water and Energy Development Company Private Limited**		
Owner's Engineer	**Tractebel Engineering GmbH / Jade Consult**		
REVIEW NOTE			
Contractor	**Doosan Enerbility**		
Title of the Document	Physical Model Test Study Report of Desander Basin		
Document No.	UT1-C-030-CVL-TE-40011	Revision	0B
Date of Documents	03.04.2022	Received Date	04.04.2022
Transmittal Form No.	UT1-HEP-DHI-D-0195		
Previous Review Date/Status	28.02.2022/RR	Prev. Review Note No.	RN-0067
Review Note No.	**RN-0117**	**Present Review Date**	**30.04.2022**
		Present Review Status	**RR**
A: Approved AN: Approved as Noted RR: Returned for Resubmission FI: For Information, only.			

Summary

The recommended dimensions for the desanding basin given in the model test study report are not approved for

(i) violating the contractual design criterion that *„the average horizontal flow velocity in the desander chambers shall be 0.2 m/s"*.

(ii) not demonstrating any improvement of the recommended design over the contractual design

(iii) inconclusive presentation of model similarity of selected model sediment scale for both sedimentation and flushing processes.

Requirements quoted from EPC Contract:

- ***ANNEX 13, Employer´s Requirements, Part B, Design Requirement (1. Main Body)***

J. The desander chambers shall be designed for 90% removal of over the 0.2 mm sediment particles.
K. The average horizontal flow velocity in the desander chambers shall be 0.2 m/s.

- ***ANNEX 13, Employer´s Requirements, Part A Project Construction Requirements*:**

D. The desander chambers shall be designed for 90% removal of 0.2 mm and larger diameter sediment particles to minimize turbine damage.
E. The average horizontal flow velocity in the desander chambers shall be 0.2 m/s.

Comments on Selective Issues of significance in the Report

Section 1.2 Layout of Desander Basin:

- The report is not clear about the layout and design of the system at:

(i) the start of the tests, e.g. the Basic Design as being integral part of the EPC Contract, and

(ii) at the end of the tests, i.e. recommended finally optimised layout.

Which configurations have been subject to simple settling calculation, physical model tests, and mathematical-numerical model tests.
The length of the „diffusion section“ (section downstream of the u/s gate to equalise the flow conditions across the entire cross section u/s of the „working section“ of the desander) has not been subject to modifications and has not been optimised, but applied as L = 33.5 m in the „ Layout Drawing “ (Doosan, 28 July 2021), which is different from the „Contract Design“ (Daelim/Kyeryong, December 2017) (L = 28.0 m).

- The „final recommended working section“ is 100 m long, 10 m wide and 9.50 m deep. However, the design section as given in the EPC contract is 115 m long, 10 m wide and 14.30 m deep.
  What is the improvement of the „final recommended working section“ over the initial design section except for reducing excavation quantities?
- From the geometric dimensions named as „final recommended“ the cross section can be calculated as 10 m x 9.5 m = 95 m^2. The design discharge per basin is 76 m^3/s / 3 = 25.33 m^3/s. The resulting horizontal average velocity in the desander is 25.33/95 = 0.267 m/s.
  This is a violation of basic design requirement stated under para K under Part B (para E under Part A, respectively).
- Further: The ratio of width over height of the desander basins should not fall below unity. Instead, a ratio in the range of 1.5 to 2.0 m is recommended.

Section 2.1 Contract Requirements of the Desander Basin

- The section is incomplete and not stating the above requirement (para K under Part B, and para E under Part A, respectively) regarding average horizontal flow velocity.

Section 2.2 Generation Flow and Sediment Concentration

- The average annual suspended sediment concentration is not relevant for the dimensioning of the desander. It is rather the floods with high sediment concentration during the monsoon period July to September which generate the sediment load threatening the sustainability of the turbine blades. Therefore, much higher sediment loads – representing such monsoon floods - should be studied and included in the model tests.

Section 2.3 2.3 Gradation and Adjustment of Suspended Sediment Particles

- The removal of particles >0.2 mm from the model sediment alters the settling and moving behaviour of the suspended sediment. A test should be carried out which demonstrates that both sediment gradations (i) original, and (ii) gradation with removed particles <0.2 mm behave similar, in order to validate the chosen modelling philosophy.
- Also, smaller size particles will settle and have an impact on deposited volumes and flushing quantities.

Section 3 Study Purpose and Content

- Quote: Para (7): It is to optimize the cross-section of the desander basin, and repeat the above test items (4), (5) and (6).
  No test results of physical model tests for different desander configurations were included in the model test study report.

Section 4.1 Cross-section Size of Desander Basin

- In order to avoid remobilisation of settled particles, it is good engineering design practice to design the desander dimensions that the average flow velocity does not exceed 0.2 m/s. This condition in partciular has been included in the design criteria for the desander basin (Annex 13 to the EPC Contract).
  The model tests do not take note of this criterion.

Section 4.2 Determination of Desander Basin Length

- Page 14: quote *„The particle size of suspended sediment in Upper Trishuli 1 Hydroelectric Project varies from 0.25 mm to 0.7 mm, …“*.
  This sentence is incorrect. The suspended sediment contains also particles of larger and smaller sizes.

Section 4.2.2. Supersaturated Sediment Transport Method

- No data are given on sediment concentrations applied in the calculations. Here, the high sediment concentrations during floods in monsoon season should be reflected.
  The results in Table 4.2-3 confirm the known fact that at similar flow velocities (similar cross section areas) the basin length is shorter for wider basins and longer for higher/deeper basins (resulting in the recommendation of a width/heigth relation >1).

Section 5.2 Flushing Calculation Results

- Calculations with average sediment concentration do not represent the actual nature of sediment concentration in the river changing with time.
  Calculations should consider high and changing concentrations according to typical monsoon events.

Section 6.1 Physical Model Design

- Model similarity: The selected scale for the sediment particles is l_d = 2.53. There are at the same time different scales for different particles given (l_d = 1.97 and l_d = 15). There should be only one scale factor for sediment although there are different sizes of different fractions. This factor should be chosen to either represent the similarity of settling motion (settling in desander basin), or the initiation of motion (flushing).

Section 6.2.2 Preparation of Suspended Sediment

- No justification for material based on a scale factor of l_d = 2.53 has been given!
  Selection of correct model sediment and the right scale fort he selected purpose of testing is key to validity of figures derived from the model tests. There is no adequate description given on which similarity criterion has been applied for which series of model tests and how the model scale factor has been derived. Without transparent prove of this process, including tests which should have been carried out to prove the similar behaviour of prototype and model sediment, any quantitive figures of the tests can not be transferred on to the prototype.

Section 7 Deposition and Flushing Test of Desander Basin

- The average annual suspended sediment concentration has been used in the tests. However typically much higher sediment concentrations (ppm) during floods during monsoon are relevant for the design and should be applied in the tests, not annual average values.
- The absolute figures obtained as results in the model tests are only valid if the similarity between model sediment and prototype sediment is reflected correctly in the model. If the model type sediment particles are too large the removal rate is overestimated and vice versa. Therefore, the selection of sediment is key to success of model testing. Therefore, only relative results from model tests for alternative configurations can reliabily compared and ranked against each other. Absolute quantative values stated are questionable.

Section 7.4 Optimization Design of the Desander Basin

- No optimisation has been carried by the model tests. Rather simplified calculation have been presented to calculate theoretical length of desander basin for settling. However, by reducing the cross section area while keeping the flow depth, the average flow velocity has been increased beyond the contractually required flow velocity of 0.20 m/s. Therefore, this part of optimisation is violating the design criteria.
- There is no comparision of the model test results of original design and recommended design. Only figures for recommended design are presented.

Section 7.7 Flushing of Desander Basin in the Recommended Scheme

- The scale of sediment for flushing tests shall be demonstrated in a similar way as required for settling. The resulting scale factor to achive similarity in flushing behaviour may be different from the scale factor required to model the settling process.
  Here similarity of initial motion of sediments is relevant as well as the effect of cohesion, which can not be simulated. Therefore, test results can validly applied for relative ranking of alternative configurations or operational procedures rather than deriving absolute figures for flushing amounts and durations of the flushing process.

Section 8 Hydraulic Simulation for Desander Basin

Section 8.1 Head Loss of Intake Tunnel

- The head loss calculations do not account for the separation wall introduced at the beginning of the trifurcation. These will have an additional effect on the total annual energy output of the plant.

Section 8.2 Velocity Distribution in Desander Basin

- The results of the mathematical-numerical simulation show that the bottom flow velocity is for larger reaches of the desander basin between 0.50 m/s and 0.70 m/s, which exceeds critical velocities for sedimentation and supports remobilisation of settled particles. These results have not been commented upon in the model test study report by the author. The results directly ask for alternative configurations to compare the results and select better configurations for the recommended, optimised configuration.

Section 8.3 Flow Distribution Through Bifurcation

- The configuration actually shows a trifurcation.
- The original design of the trifurcation showed an uneven and unbalanced discharge distribution for the three desander basins. After introduction of two 25 m long separation walls (37 cm thick) in the middle of the tunnel (resulting in a section width of 146 cm) upstream of the trifurcation a much better, balanced flow distribution across the three desander basins at design discharge is achieved.
  The situation at flow less than design discharge should also be documented.
- Additional head losses introduced by these two walls should be calculated.

Section 8.4 Physical Model Verification

- The balanced flow distribution after introduction of the dividing walls has been confirmed through physical model test.
  A confirmation of the unbalanced situation of the original design has not been documented. This would be useful for the process of calibration of the mathematical-numerical model.
- No optimisation of the length of the separating walls has been documented. The length of the wall should be varied.

DISCLAIMER

Any approval will not release the Contractor from any of his obligations under the Contract.

Dr. Frank Negrassus/ Sebastian Beck, Chief Design Engineer